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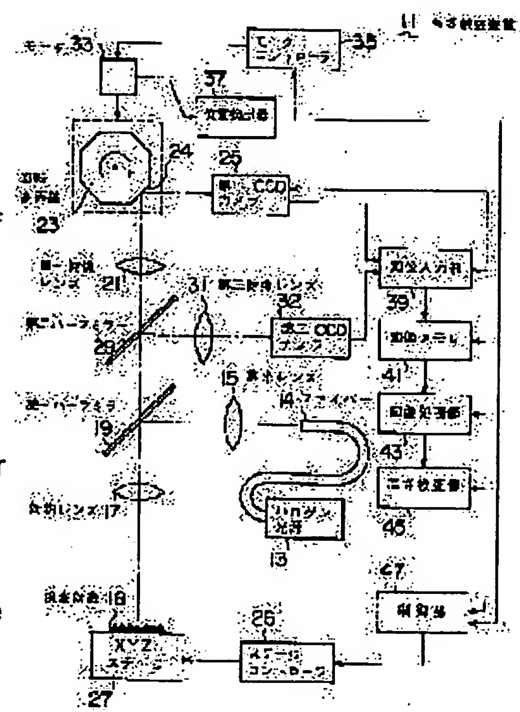
(54) HEIGHT INSPECTION DEVICE

(57)Abstract:



PROBLEM TO BE SOLVED: To shorten the time required for inputting pictures to a height inspection device, at the time of inspecting an object to be inspected for height, by making the vertical movement of the object or lens barrel unnecessary.

SOLUTION: The height inspection device 11 is constituted in such a way that the light emitted from a halogen light source 13 and reflected by an object 18 to be inspected is again reflected by a rotary polygon mirror 23 having a plurality of reflecting surfaces 24 which are positioned at different distances from the center of rotation of the mirror 2 after passing through an objective lens 17, a first half mirror 19, and a first image forming lens 21 and forms an image in a first CCD camera 25. When the reflecting surface of the mirror 23 changes while the mirror 23 is rotated by means of a motor 33, the length of the optical path from the first image forming lens 21 to the first CCD camera 25 changes and the focal plane moves upward and downward against the optical axis and, at the same time, the focal point is deviated in the vertical direction. Therefore, the focusing states of a plurality of pictures obtained by means of a picture

processing section 43 are different from each other. The inspection device 11 calculates the height of the object 18 by detecting the height of the deviation on the picture taken with the CCD camera corresponding to the most focused picture by using a height inspecting section 45 by evaluating the focusing states of the pictures.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to height test equipment. And it is related with the height test equipment which detects the height of the detected body especially using an optical means. The flip-chip-bonding method which connects the surface electrode on an LSI chip to an insulating substrate or the electrode for wiring of a package directly in connection with the formation of many pins of an LSI chip in recent years and densification (bonding) attracts attention.
[0002] The area bump formed on LSI chip 201 at drawing 9 (wen of solder.) Hereafter, a bump is called. The schematic diagram of the appearance of 202 is shown. In practice, on the LSI chip around 10mm, the bump with a diameter of about 100 micrometers who did the globular form mostly is formed for one side about thousands of pieces. A bump does the face down of LSI chip 201, and bonding is done to a substrate 203. The method which mounts two or more LSI chips in one substrate is called an MCM (multi-chip module) method. MCM is used for a high performance computer etc.
[0003] If dispersion is in a bump's 202 size (a path or height), when a face down is carried out, as shown in drawing 10 , the short defect 204 or the opening defect 205 will arise. Therefore, it becomes important in prevention of a defect to inspect a bump's 202 size before a face down, and to discover poor size. Since thousands of bumps are formed in high density, the area bump is very difficult for human being inspecting each bump's size by viewing. Therefore, automation of a bump's visual inspection is desired.
[0004]
[Description of the Prior Art] The configuration of the optical system of conventional height test equipment is shown in drawing 11 . In conventional height test equipment 211, it reflects by the half mirror 216 and the light which came out of the halogen light source 212 is irradiated through an objective lens 217 by the subject of examination 218 on the XYZ stage 223, after being led to a lens-barrel 214 with a fiber 213 and being condensed with a condenser lens 215. After it is condensed with an objective lens 217 and the light 219 reflected from the subject of examination 218 penetrates a half mirror 216, image formation of it is carried out with the image formation lens 220, and it is picturized with CCD camera 221 and an image processing system 222.
[0005] Next, the procedure of height inspection using conventional height test equipment is explained. First, a subject of examination 218 is positioned so that a suitable inspection location can be secured on the XYZ stage 223. And the step of making predetermined height carrying out vertical migration of the subject of examination 218 by the Z stage of the XYZ stage 223, and picturizing is repeated. The depth of focus of a lens system is fully shallower than the migration length of one step of a Z stage.
[0006] In addition, not carrying out vertical migration of the Z stage of the XYZ stage 223, moving a lens-barrel 214 up and down, and picturizing may also be performed. The conventional height detection method is explained using drawing 12 . As shown in drawing 12 (a) and (b), by the top-most-vertices section 234 of the bump 233 on a chip 232, since it reflects right above, the light 231 irradiated from right above is bright, since it reflects in the direction of slant in a ramp 235, it is dark, and is picturized

by the in-between brightness (gray tone) of ******** in the chip field 236. Although the profile of brightness which met the A-B line of drawing 12 (b) is shown by drawing 12 (c) and (d), its focus of the suits and it changes with condition.
[0007] The profile of drawing 12 (c) is a profile of the brightness in the condition that the focus suited the bump top-most-vertices section 234 (height Z1), and drawing 12 (c-2) expresses the profile with the differential value of brightness. Moreover, the profile of drawing 12 R> 2 (d) is a profile of the brightness in the condition (height Z2 or Z3) that the focus shifted from the bump top-most-vertices section 234, and drawing 12 (d-2) expresses the profile with the differential value (rate of change) of brightness.
[0008] After the focus has suited the bump top-most-vertices section 234 (height Z1), brightness becomes large with S1 like drawing 12 (c), and the absolute value of the differential value of the brightness is also large like drawing 12 (c-2). After the focus has shifted from the bump top-most-vertices section 234 (height Z2 or Z3), like drawing 12 (d), brightness becomes small with S2 and becomes small like drawing 12 (d-2) of the absolute value of the differential value of the brightness.
[0009] Therefore, the height information on bump top-most vertices can be acquired by detecting the height of an image pick-up in case the brightness of the bump top-most-vertices section 234 or the magnitude of a differential value becomes max using the XYZ stage which performs height (Z direction) accommodation to be examined. The above height detection method is usually called the focal method.
[0010]
[Problem(s) to be Solved by the Invention] In the height test equipment using the conventional focal method, as shown in drawing 11 , in order to change the distance from a subject of examination 218 to a lens-barrel 214, the Z stage of the XYZ stage 223 was used. However, compared with the imaging time of CCD camera 221, transit time became long, and it had the problem of taking image input time amount.
[0011] Moreover, also when moving a lens-barrel 214, generally weight of the lens-barrel was large, and when making it fluctuate using a XYZ stage etc., it had the physical or cost-problem that generating of vibration used as active jamming of inspection and a large-sized and powerful Z stage were needed etc. Therefore, in a height inspection to be examined, vertical migration of a location to be examined or the location of a lens-barrel is made unnecessary, and it becomes a technical problem that image input time amount is shortened.
[0012] This invention aims at offer of the new height test equipment which solved the above-mentioned technical problem. Moreover, another purpose of this invention aims at offer of the height test equipment which makes unnecessary vertical migration of a location to be examined or the location of a lens-barrel by adoption of new optical system.
[0013]
[Means for Solving the Problem] Invention according to claim 1 is characterized by changing the optical path length between a subject of examination and the photosensor to provide, and having the optical system which changes this height information to be examined into the positional information on this photosensor in the height test equipment which inspects height to be examined. Invention according to claim 2 is characterized by said optical system being what possesses a movable reflective means and changes height information to be examined into the positional information on said photosensor according to migration of this reflective means in height test equipment according to claim 1.
[0014] it is constituted by the reflector of 1 where invention according to claim 3 was equipped with the rotating polygon which said optical system becomes from two or more reflectors where the distance from the center of rotation differs in height test equipment according to claim 2, and it was chosen from the reflector of this plurality [means / said / reflective], and migration of said reflective means is based on rotation of this rotating polygon -- this -- it is characterized by being made with selection of the reflector of 1.
[0015] Invention according to claim 4 is characterized by the reflector of said rotating polygon being a multiple drill configuration with the substantial configuration which has an inclination toward the center of rotation and this reflector constitutes, or a multiple frustum configuration in height test equipment

according to claim 3. Invention according to claim 5 is characterized by the difference of said center of rotation of said reflector where said rotating polygon adjoins further to distance having a rough ****** part and a dense part in height test equipment according to claim 3.
[0016] Invention according to claim 6 is characterized by for said rotating polygon combining the mirror body with which it is constituted by said reflector where the distance from a medial axis used as said center of rotation is equal, and the field of the same number, and thickness differs on the field of this body on the rotating-polygon body whose configuration in a cross section perpendicular to this medial axis is a regular polygon substantially, and forming it in height test equipment according to claim 3.
[0017] Invention according to claim 7 is set to height test equipment according to claim 2. Said optical system It has two or more rotating polygons which consist of two or more reflectors where the distance from the center of rotation differs. Said reflective means It consists of each reflectors of two or more of two or more rotating polygons with the group of two or more reflectors chosen every one each. this -- migration of said reflective means this -- it is characterized by being what is made by choosing a reflector from each reflectors of two or more of two or more rotating polygons by every one rotation each according to each center of rotation.
[0018] Invention according to claim 8 is set to the height test equipment of claim 3 thru/or claim 6 given in any 1 term. While providing further a light irradiation device, the second photosensor, and the image processing system that performs the image processing for changing said height information to be examined into the positional information on this photosensor with directions of this second photosensor This light irradiation device and the second photosensor are set up so that the light from this light irradiation device may form the optical axis and parallel condition of this photosensor at the time of the completion of selection of the reflector of 1 by rotation of the aforementioned rotating polygon. This photosensor detects formation of this parallel condition at the time of rotation of this rotating polygon, and it is characterized by making this image processing by this image processing system by these directions following this detection.
[0019] In height test equipment according to claim 3, while said second photosensor consists of two or more bodies of a sensor, invention according to claim 9 These two or more bodies of a sensor are constituted so that other bodies of a sensor and the optical axis of each of the light from this light irradiation device at the time of the completion of selection of the aforementioned reflector may be pinched, and it is characterized by being what detects formation of said parallel condition with the substantial identitas of the amount of detection of this light in each body of a sensor.
[0020] According to claim 1 and height test equipment according to claim 2, the optical system used for height inspection can acquire this image as a difference in the television location on this photosensor light-receiving side by changing the optical path length between the photosensors which televise the image as a subject of examination and this height information to be examined. And this optical path length can be made adjustable according to a subject of examination and the movable reflector where this optical system possesses independently.
[0021] Therefore, while there is no need of moving a subject of examination up and down and requiring long duration to the up-and-down actuation called for, it is not necessary to depend on subject-of-examination rise-and-fall means, such as a XYZ stage which may give vibration which can serve as active jamming of inspection to a subject of examination. Therefore, a large optical-path-length change in a short time can be made without giving vibration to a subject of examination, and the height test equipment which conducts exact height inspection for a short time can be offered.
[0022] The optical system which is used for height inspection according to height test equipment according to claim 3 is equipped with two or more reflectors where the distance from the center of rotation differs, and has a rotating polygon with two or more reflectors able to constitute a part of optical path of the light which a subject of examination all emits by this rotation which it is pivotable and are this provided. Therefore, by choosing this reflector by this rotation of this rotating reflector, the optical path length between the photosensors which televise the image as a subject of examination and this height information to be examined can be changed, and it is possible to acquire this image for the difference in this optical path length as a difference in the television location on this photosensor light-

receiving side.
[0023] Therefore, while it is possible to acquire this height information to be examined as a difference in the television location on this photosensor light-receiving side, and there is no need of moving a subject of examination up and down and requiring long duration to the up-and-down actuation called for, it is not necessary to depend on subject-of-examination rise-and-fall means, such as a XYZ stage which may give vibration which can serve as active jamming of inspection to a subject of examination. As mentioned above, the height test equipment which conducts exact height inspection for a short time can be offered, without giving vibration to a subject of examination for large optical-path-length modification in a short time.
[0024] By establishing the inclination which goes to the center of rotation in the reflector of the rotating polygon to be used according to height test equipment according to claim 4, in case the light which comes from a subject of examination is reflected and it sends to a photosensor, the degree of freedom of the reflective direction becomes possible [increasing and reflecting light as desired according to the direction needed]. Therefore, the height test equipment which conducts exact height inspection can be offered.
[0025] According to height test equipment according to claim 5, the difference of the distance from the center of rotation in an adjacent reflector becomes possible [using the rotating polygon which is not necessarily fixed]. Therefore, in the height range to inspect, in the range to inspect by the high resolution, or the range of the height neighborhood of a subject of examination, the difference of the distance from the center of rotation in an adjacent reflector can be made dense, height inspection can be carried out with high resolution, and it can inspect by rough-**(ing) in the range which is not so.
[0026] Therefore, a large optical-path-length change in a short time can be made without giving vibration to a subject of examination, and the height test equipment which conducts exact height inspection for a short time can be offered. According to invention according to claim 6, in height test equipment, the comparatively easy rotating polygon which can be manufactured cheaply can be used for the rotating polygon for optical-path modification to be used.
[0027] Therefore, the cheap height test equipment which conducts exact height inspection for a short time can be offered. It becomes possible according to invention according to claim 7 to prepare two or more rotating polygons, it becomes possible to change the optical path length more finely, and it becomes possible to conduct height inspection with high resolution.
[0028] Therefore, the cheap height test equipment which conducts exact height inspection for a short time can be offered. According to claim 8 and invention according to claim 9, it becomes possible to make it rotation of the rotating polygon which changes the optical path length interlocked with, and to perform image acquisition to be examined with a photosensor, and becomes automatable [inspection].
[0029] Therefore, a large optical-path-length change in a short time can be made without giving vibration to a subject of examination, and the height test equipment which conducts exact height inspection automatically for a short time can be offered.
[0030]
[Embodiment of the Invention] The inspection principle of this invention is explained using drawing 1 , drawing 2 , and drawing 3 . Supposing the case where incidence of the light for inspection is carried out to a subject of examination, drawing 1 - drawing 3 show the behavior of the reflected light, and show an inspection principle, drawing 1 is drawing explaining the inspection principle of this invention using migration of a reflective mirror, and drawing 1 (a) shows signs that image formation of the light which came out of the point P1 on the datum level established in the focal location of the optical system for inspection is carried out with an objective lens 1.
[0031] Although image formation of the light which came out of the point P1 is carried out to a point R1 properly speaking, image formation is carried out to the point Q1 on the image formation side which only distance D separated from the optical axis 3 by the reflective mirror 2 which is in the optical-axis 3 direction in a location X1. Drawing 1 (b) shows signs that image formation of the light which came out of the point P2 of objective lens 1 approach rather than datum level is carried out with an objective lens 1. Although image formation of the light which came out of the point P2 will be carried out to the point

which is separated from an optical axis 3 from a point Q2 if the reflective mirror 2 is in a location X1, image formation can be carried out to the point Q2 which distance D Is separated from an optical axis by moving the location of the reflective mirror 2 to X2.

[0032] At this time, the distance to a point Q2 of the optical path length from an objective lens 1 to an image formation side is longer than a point Q1 so that clearly also from physical relationship with points R1 and R2. Drawing 1 R> 1 (c) shows signs that image formation of the light which came out of the point P3 which separated is carried out with an objective lens 1, from the objective lens 1 rather than datum level. Drawing 1 (b) Image formation of the light which came out of the point P3 can be similarly carried out to the point Q3 which distance D Is separated from an optical axis by moving the location of the reflective mirror 2 to X3. At this time, the distance to a point Q3 of the optical path length from an objective lens 1 to an image formation side is shorter than a point Q1 so that clearly also from physical relationship with points R1 and R3.

[0033] Therefore, by adjusting the location of the reflective mirror 2 which is in the latter part of an objective lens 1 to point P1-3 which emit light, from an optical axis, on the same familiar field, the location can be changed and fixed distance can carry out image formation of the image of the field where the distance to an objective lens 1 differs, as shown in drawing 1 (d). Drawing 2 is drawing explaining the inspection principle of this invention using a rotating polygon, it condenses the light reflected from the location P11 on a side [to be examined] (object side) to be examined with an objective lens 5, changes an optical path in the reflector M1 to which the rotating polygon (8 face piece structures of reflectors M1-M8) 6 inclined 45 degrees, and shows signs that the image formation side arranged perpendicularly is made to carry out image formation. In addition, in the case of this invention, this image formation side turns into a sensor side of photosensors, such as a CCD camera, so that it may explain later.

[0034] Rotating polygons 6 differ in the distance (a radius of gyration is called henceforth) from the center of rotation 7 to each reflector (M1-M8) to R1-R8. The input to the sensor side of the image which is the light which emitted P11 rotates a rotating polygon 6, switches a reflector in order to M1-M8, and is performed in the location where reflectors M1-M8 become 45 degrees. In this case, the reflector of a rotating polygon 6 inputs this image, whenever those with the 8th page and a rotating polygon 6 rotate 45 degrees.

[0035] Since the distance from a subject of examination to an objective lens 5 changes when height to be examined changes, in order to double a focus on a sensor side, it is necessary to change the optical path length from an objective lens 5 to a sensor side. At this time, a rotating polygon 6 acts effective in change of the optical path length by suitable selection from them using the reflector of a different radius of gyration to provide.

[0036] Drawing 3 is drawing explaining the inspection principle of this invention using the difference in the location of the reflector of a rotating polygon, and expands and shows signs that the optical path of the reflected light 8 changes with the differences in the location (radius of gyration) of the reflector (M1, M2) of a rotating polygon 6. Among drawing, an optical path is changed using a reflector M1, and, as for the rotating polygon 6 shown as a continuous line, the rotating polygon 6 shown by the dotted line changes an optical path using a reflector M2.

[0037] Image formation of the light which made an optical-path change in the reflector M1 (radius of gyration R1) is carried out to the location Z1 of a sensor side, and it is to the point. On the other hand, image formation of the light which made an optical-path change in the reflector M2 (radius of gyration R2) was carried out to the upper location Z2 from the location Z1 in the sensor side, and the focus has faded. If the profile of the optical reinforcement on a sensor side shows these situations, as shown in drawing 3 (b) and (c), by drawing 3 (b) at the time of using a reflector M1, optical reinforcement will be high and the reinforcement will become high clearly compared with drawing 3 R> 3 at the time of using a reflector M2 (c).

[0038] This is for acting so that the optical path length from an objective lens 5 to the sensor side of a photosensor may be changed, when a rotating polygon 6 switches the reflector (M1-M8) where radii of gyration differ. Thus, if the reflector where the radii of gyration of a rotating polygon differ is switched

and the optical path length is changed, while a focus will suit and condition will change, a detectable location also changes. Therefore, when the image whose focus of the suited most is extracted out of two or more images which made an optical-path change and which were inputted in two or more reflectors where radii of gyration differ and the Z direction location on the sensor at that time detects, height to be examined is computable.
[0039] That is, height information to be examined can be changed into the positional information on a sensor, and the height can be detected. In addition, the difference of the distance from the center of rotation in the reflector where a rotating polygon 6 adjoins each other may not necessarily be fixed at this time. Although drawing 4 is drawing showing the image formation location (Z1-Z8) on the sensor side corresponding to the distance from the center of rotation of each reflector of a rotating polygon As shown in drawing 4 (a) and (b), in the height range to inspect, the consistency of an image formation location may rough-** densely in the range which is not so in the range to inspect by the high resolution, or the range of the height neighborhood of a subject of examination.
[0040] A highly precise height inspection of the required part within the limits restricted by preparing ** and ** of an image formation location such is attained. the conventional measuring method -- getting twisted -- measuring range was a successive range to be examined by the means of a XYZ stage etc., when it was going to rough-** the consistency of the image formation location in height inspection, needed to move the subject of examination by the XYZ stage so much, and had required the duration proportional to the migration length. Therefore, height inspection in the large range was not desirable.
[0041] However, in the height test equipment by the height inspection principle concerning this invention, it is able for the actuation corresponding to the migration to be examined by the means of the XYZ stage in a conventional method etc. to be able to attain by rotation of a rotating polygon in an instant, to be able to omit sharply the time amount for moving the subject of examination in height inspection, and to set the inspection range as the very large range compared with the former.
[0042]
[Example] Hereafter, the example which starts this invention using a drawing is explained.
(Example 1) Drawing 5 is the block diagram showing the important section configuration of the height test equipment which is the first example concerning this invention.
[0043] Explanation is given below focusing on the configuration and operation of optical system used as the important section of this equipment. The optical system of the height test equipment 11 of this example is constituted considering the halogen light source 13, a condenser lens 15, an objective lens 17, the first half mirror 19, the first image formation lens 21, and a rotating polygon 23 and first CCD camera 25 as a photosensor as the principal part.
[0044] And the stage controller 26 is provided and it has further the XYZ stage 27 in which positioning to be examined is possible, the second half mirror 29, the second image formation lens 31, and second CCD camera 32. In addition, a condenser lens 15, an objective lens 17, the first half mirror 19, the first image formation lens 21, a rotating polygon 23, the second half mirror 29, and the second image formation lens 31 are dedicated to a lens-barrel (not shown), and are united.
[0045] The rotating polygon 23 for optical-path-length modification has the motor 33 possessing the motor controller 35 for rotation, and a motor 33 combines and has the location detection machine 37 in control of rotation actuation further. moreover, a basis [picture signal / which acquired height test equipment 11 with second and first CCD cameras 32 and 25] -- positioning of a subject of examination 18 -- and in order to conduct height inspection, it has the image input section 39, an image memory 41, the image-processing section 43, and the height Banking Inspection Department 45.
[0046] And while controlling image input section 39 grade and controlling the processing facility of the image of equipment 11, if it is directed to control of the XYZ stage 27, and a position transducer 37 through the stage controller 26 and a motor 33 is pulled through the motor controller 35, it has the control section 47 which controls a rotating polygon 23. In the height test equipment 11 of this example which consists of the above configuration, it reflects by the first half mirror 19, and the light by which outgoing radiation was carried out from the halogen light source 13 irradiates the subject of examination 18 which is a semiconductor chip through an objective lens 17, after being led to this lens-barrel with

the optical fiber 14 attached in the halogen light source 13 and being condensed with a condenser lens 15.

[0047] After it is condensed with an objective lens 17 and the light reflected from the subject of examination 18 penetrates the first half mirror 19, it branches in the light reflected in the second image formation lens 31 side by the second half mirror, and the light penetrated to the first image formation lens 21 side. Image formation of the light which reached the second image formation lens 31 is carried out to second CCD camera 32. The depth of focus of the optical system of the second image formation lens 31 is made deeper than the optical system of the first image formation lens 21 using a diaphragm, and the image of the large range picturized with second CCD camera 32 is used for positioning including detection of extent of an inclination to be examined etc.

[0048] It is reflected by the rotating polygon 23 and image formation of the light which reached the first image formation lens 21 is carried out with first CCD camera 25. A rotating polygon 23 has two or more reflectors (mirror) 24, and the distance from the center of rotation to each reflector differs, respectively. In addition, the number of reflectors is determined from resolution in the height range and height to picturize. Therefore, it is also possible to change into the above-mentioned rotating polygon of the 8th page if needed, and to use the rotating polygon of the smaller number of pages and what has many [more] numbers of fields. Here, the number of reflectors is the 8th and the range difference from the center of rotation between each reflector is about dozens of micrometers.

[0049] When the optical axis of light which rotated the rotating polygon 23 by the motor 33, and was reflected in the reflector 24 becomes perpendicular to first CCD camera 25, it picturizes by applying an input trigger to the first CCD camera. If a reflector changes and the location changes as drawing 1 (a) and (b) were shown, the optical path length from the first image formation lens 21 to first CCD camera 25 will change. That is, a focal plane fluctuates.

[0050] The location (include angle) detector 37 is combined with the shaft of the motor 33 made to rotate a rotating polygon 23, and this output is fed back to the motor controller 35, and it controls to a fixed rotational frequency. In addition, a rotary encoder etc. can be used for this location (include angle) detector. A control section 47 incorporates the output of a position transducer 37, outputs a trigger signal to the time of day when the reflector 24 of a rotating polygon 23 becomes 45 degrees to the image pick-up side of first CCD camera 25 (the optical axis of light reflected in the reflector 24 becomes perpendicular to first CCD camera 25 (image pick-up side) at this time.), and performs a shutter image input.

[0051] Time amount after a control section 47 undergoes the output of a position transducer 37 until it carries out a shutter image pick-up is about hundreds of nanoseconds. When imaging time of a camera is made into 1 / 30 seconds and there are eight reflectors, a rotation period is 0.2666 seconds and rotational speed is per minute 225 rotation. Or it positions by directing the angle of rotation of a rotating polygon, and an image input may be performed after a rotating polygon stops.

[0052] Next, the procedure of height inspection is explained. The XYZ stage 27 moves an image pick-up field so that an image can be inputted as positioning of a subject of examination 18 in each field on a chip. The image of a rotating polygon 23 made one revolution is captured to one field. The picturized analog picture signal is changed into the digital image signal of 256 gradation in the image input section 39, and is stored in an image memory 41. The optical axis after reflecting the inputted image in a reflector according to the detection principle mentioned above shifts perpendicularly.

[0053] Therefore, although the field inputted shifts horizontally on the image pick-up side (sensor side) of the first CCD camera, since it is fully small compared with the visual field of optical system, such as a CCD camera, from the above-mentioned order (dozens of micrometers), there is no effect of [on height inspection]. The focus of two or more images inputted in one field obtained in the image-processing section 43 suits, and condition differs respectively. A focus suits, well-known technique which was explained with the conventional technical slack focal method estimates condition, and the height corresponding to the image whose focus suited most is detected using the height Banking Inspection Department 45.

[0054] If an inspection location to be examined is on a bump at this time, the detected height will be

height of bump top-most vertices, and size inspection of a bump will be conducted. And the time amount concerning migration of the XYZ stage which became a problem with the conventional method became unnecessary, and the momentary automatic height inspection according to rotation of a rotating polygon was attained.
(Example 2) Drawing 6 is the block diagram showing the important section configuration of the height test equipment which is the second example concerning this invention.
[0055] The height test equipment 51 which is the second example has the characteristic point compared with the first example in the device to which the image input trigger which inputs an image into first CCD camera 53 is applied, and the structure of a rotating polygon 55. And then, the main optical system for height inspection is the same as the first example, and is the same. [of the control section which controls the configurations for processing the image from the configuration and photosensor slack CCD camera for positioning, such as a XYZ stage, and these functions]
[0056] Therefore, only a characteristic part is explained using drawing 6 (a) and (b), and explanation is omitted about the part which overlaps the first example. A rotating polygon 55 has the page [8th] reflector (mirror) 57, and the distance from the center of rotation to each reflector differs, respectively. In addition, although it is natural, about evaluation of the distance, it is supposed that each distance differs between each reflector after the same criteria, such as evaluating the distance of the lower limit of a reflector and the center of rotation, estimate.
[0057] And while being set up so that the center of rotation may serve as a perpendicular (Z shaft orientations), the reflector has 45 inclinations to the center of rotation, respectively, and has the 8 truncated-pyramid-like configuration where the longitudinal section is a trapezoid. Consequently, in XZ side in the XYZ coordinate which specifies equipment 51, it will incline 45 degrees. A rotating polygon 55 is equipped with a motor 59, and serves as the center of rotation where the core of the shaft 61 of a motor 59 serves as criteria of the location of each reflector.
[0058] The device to which an image input trigger is applied has camera controller 71 with another laser light source 62, condenser lens 63, third half mirror 65, third photosensor 67, trigger generator 69, and above-mentioned control section. To the reflector 57 of a rotating polygon 55, the approach to which an image input trigger is applied is the direction of bottom 45 degrees of slant at XZ flat surface, and irradiates laser light from the direction which is in agreement with the optical axis of first CCD camera 53 at XY flat surface. The laser light condensed with the condenser lens 63 penetrates the third half mirror 65, and it carries out incidence to a reflector 57. And the laser light reflected in the reflector 57 is reflected by the third half mirror 65, and the third upper photosensor 67 detects.
[0059] two bordering on XY flat surface as the third photosensor 67 is shown in drawing 5 (b) -- it consists of independently bodies 73 and 75 of a photosensor which can detect optical reinforcement. Therefore, when each luminous intensity divided on this boundary in the case of the incidence of laser light is detected with the bodies 73 and 75 of a photosensor as the same, a trigger generator 69 outputs an indication signal to the camera controller 71, and first CCD camera 53 performs a shutter image input.
[0060] Compared with the height test equipment of the first example, it is more direct, and the exact automatic height inspection of how to take the timing of a shutter image input according to an exact shutter image input was attained.
(Example 3) Drawing 7 is the block diagram showing the important section configuration of the height test equipment which is the third example concerning this invention.
[0061] Compared with the first example, two rotating polygons are used for the height test equipment 81 which is the third example, and it has the characteristic part at the point that arrangement of the first CCD camera is changed corresponding to it. About other configurations, it is the same as that of the first example, only a characteristic part is explained using drawing 6 (a) and (b), and explanation is omitted about the part which overlaps the first example.
[0062] First CCD camera 87 turns the image pick-up side downward, and is installed in the upper part where the second rotating polygon 85 carries out [in] the center of rotation too horizontally [the] at a perpendicular (Z shaft orientations), and is installed by the first rotating polygon's 83 making the center

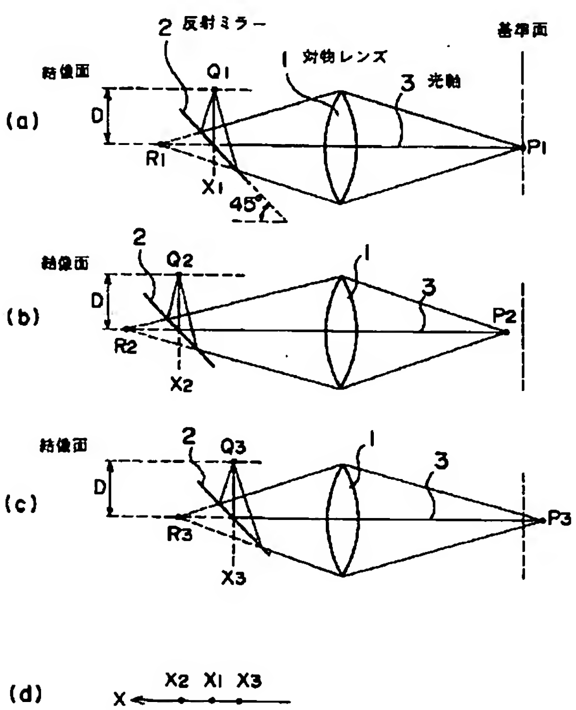
of rotation a perpendicular (Z shaft orientations), and installing it in the location of the rotating polygon (23) of the first example of drawing 5 , and the first rotating polygon 83 and the second rotating polygon 85 correspond.
[0063] And the first rotating polygon 83 and the second rotating polygon 85 have the reflector (N1-N8, M1-M8) which is eight from which the distance from the center of rotation differs respectively, and each field has 45 inclinations to the center of rotation like the rotating polygon (55) used with the height test equipment of the second example of drawing 6 , and they have the 8 truncated-pyramid-like configuration where the longitudinal section is a trapezoid.
[0064] In a height inspection to be examined, as shown in drawing 7 (b), the reflector of the first rotating polygon 83 is first fixed to N1, and sequential rotation of the second rotating polygon 85 is carried out in the order of M1, M2, M3, M4, M5, M6, M7, and M8. Next, the reflector of the first rotating polygon 83 is first fixed to N2, and sequential rotation of the second rotating polygon 85 is carried out in the order of M1, M2, M3, M4, M5, M6, M7, and M8.
[0065] Thus, when a reflector is combined one by one, there is 64 kinds of combination of two fields which can be used for height inspection of the measuring object, i.e., the optical path length. Therefore, it becomes possible that the optical path length makes the height range of the detection large compared with the height test equipment of eight kinds of first example, or to conduct height inspection with finer resolution.
(Example 4) Next, the manufacture approach of an usable rotating polygon is explained to the height test equipment concerning this invention.
[0066] Drawing 8 is drawing explaining the manufacture approach of the rotating polygon which has a page [eighth] reflector. As shown in drawing 8 (a), this rotating polygon can combine and form the mirror bodies 95-102 with which it is constituted by eight fields where the distance from a medial axis 91 used as the center of rotation is equal, and thickness (t1-t8) differs on the field of a body 93 on the rotating-polygon body 93 whose configuration in a cross section perpendicular to a medial axis 91 is a regular polygon substantially. Selection of thickness is arbitrary.
[0067] Rotating-polygon body 93a whose configuration of the rotating-polygon body 93 is a forward 8 prism configuration substantially at this time is used. If a rotating polygon is formed as a mirror body using the mirror body 103 with the mirror plane which becomes parallel to the plane of union at the time of association with rotating-polygon body 93a It is a reflector parallel to the medial axis 91 used as the center of rotation, and it has the reflector where the distance from a medial axis 91 differs, respectively, and the rotating polygon which is a multiple column configuration with the substantial configuration which this reflector constitutes can be manufactured.
[0068] Moreover, rotating-polygon body 93b whose configuration of the rotating-polygon body 93 is a forward 8 prism configuration substantially is used. If a rotating polygon is formed using the mirror body 104 with the mirror plane which inclines to the plane of union at the time of association with rotating-polygon body 93a as a mirror body It is the reflector which inclined in the medial-axis side to the medial axis 91 used as the center of rotation, and it has the reflector where the distance from a medial axis 91 differs, respectively, and the rotating polygon which is a multiple frustum configuration with the substantial configuration which this reflector constitutes, or a multiple drill configuration can be manufactured.
[0069] Furthermore, rotating-polygon body 93c whose configuration of the rotating-polygon body 93 is a forward 8 truncated-pyramid configuration substantially is used. If a rotating polygon is formed as a mirror body using the mirror body 105 with the mirror plane which becomes parallel to the plane of union at the time of association with rotating-polygon body 93c It is the reflector which inclined in the medial-axis side to the medial axis 91 used as the center of rotation, and the reflector where the distance from a medial axis 91 differs, respectively is had and carried out, and the rotating polygon which is a multiple frustum configuration with the substantial configuration which this reflector constitutes, or a multiple drill configuration can be manufactured.
[0070] As mentioned above, the difference in distance is chosen from the distance from the medial axis of a reflector, and a medial axis with an adjoining reflector as arbitration, and a rotating polygon can be

manufactured. Therefore, it can set up like a wish of the range and resolution of height measurement of height test equipment concerning this invention, and a highly precise height inspection is attained.
[0071]
[Effect of the Invention] While according to claim 1 and height test equipment according to claim 2 there is no need of moving a subject of examination up and down and requiring long duration to the up-and-down actuation called for, it is not necessary to depend on subject-of-examination rise-and-fall means, such as a XYZ stage which may give vibration which can serve as active jamming of inspection to a subject of examination.
[0072] Therefore, a large optical-path-length change in a short time can be made without giving vibration to a subject of examination, and the height test equipment which conducts exact height inspection for a short time can be offered. While according to height test equipment according to claim 3 it is possible to acquire height information to be examined as a difference in the television location on this photosensor light-receiving side, and there is no need of moving a subject of examination up and down and requiring long duration to the up-and-down actuation called for, it is not necessary to depend on subject-of-examination rise-and-fall means, such as a XYZ stage which may give vibration which can serve as active jamming of inspection to a subject of examination.
[0073] Therefore, the height test equipment which conducts exact height inspection for a short time can be offered, without giving vibration to a subject of examination for large optical-path-length modification in a short time. According to height test equipment according to claim 4, the height test equipment which conducts exact height inspection can be offered. According to height test equipment according to claim 5, a large optical-path-length change in a short time can be made without giving vibration to a subject of examination, and the height test equipment which conducts exact height inspection for a short time can be offered.
[0074] According to invention according to claim 6, the cheap height test equipment which conducts exact height inspection for a short time can be offered. According to invention according to claim 7, the cheap height test equipment which conducts exact height inspection for a short time can be offered. According to claim 8 and invention according to claim 9, a large optical-path-length change in a short time can be made without giving vibration to a subject of examination, and the height test equipment which conducts exact height inspection automatically for a short time can be offered.

[Translation done.]

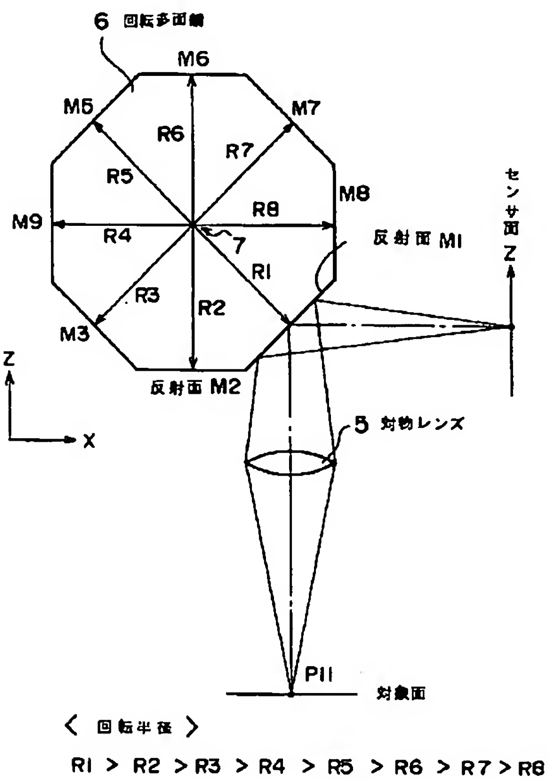
DRAWINGS

[Drawing 1]
反射ミラーの移動を利用した本発明の検査原理を説明する図



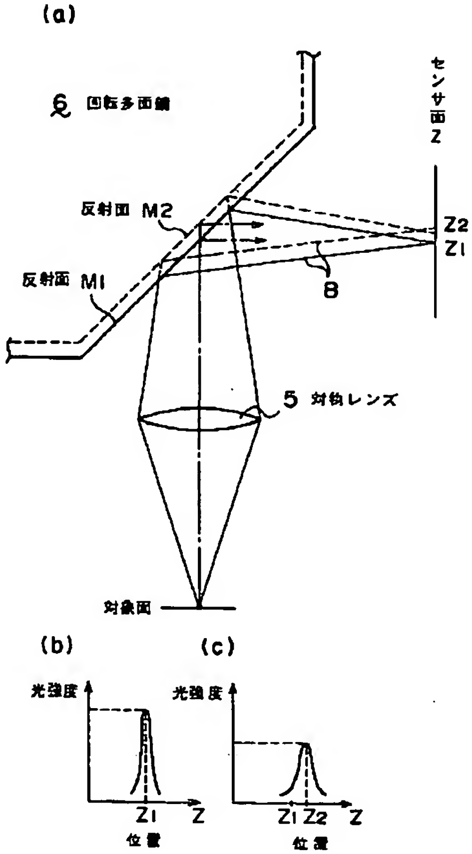
[Drawing 2]

回転多面鏡を利用した本発明の検査原理を説明する図

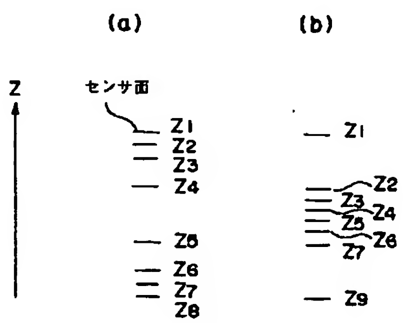


[Drawing 3]

回転多面鏡の反射面の位置の違いを利用した本発明の検査原理を説明する図

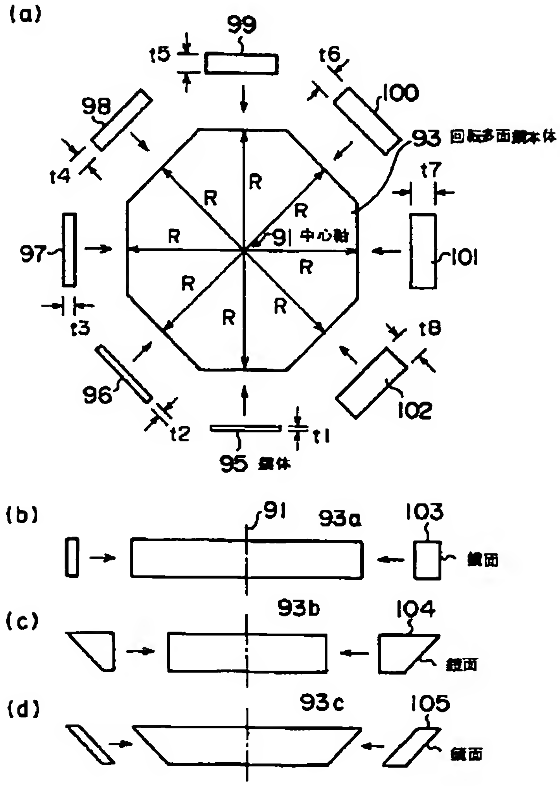


[Drawing 4]
回転多面鏡の各反射面の回転中心からの距離に対応するセンサ面上での結像位置を示す図



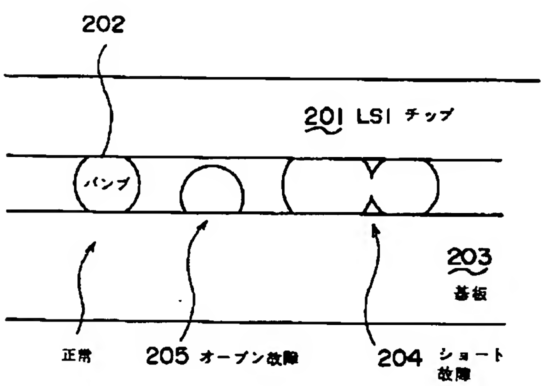
[Drawing 8]

八面の反射面を有する回転多面鏡の製造方法を説明する図



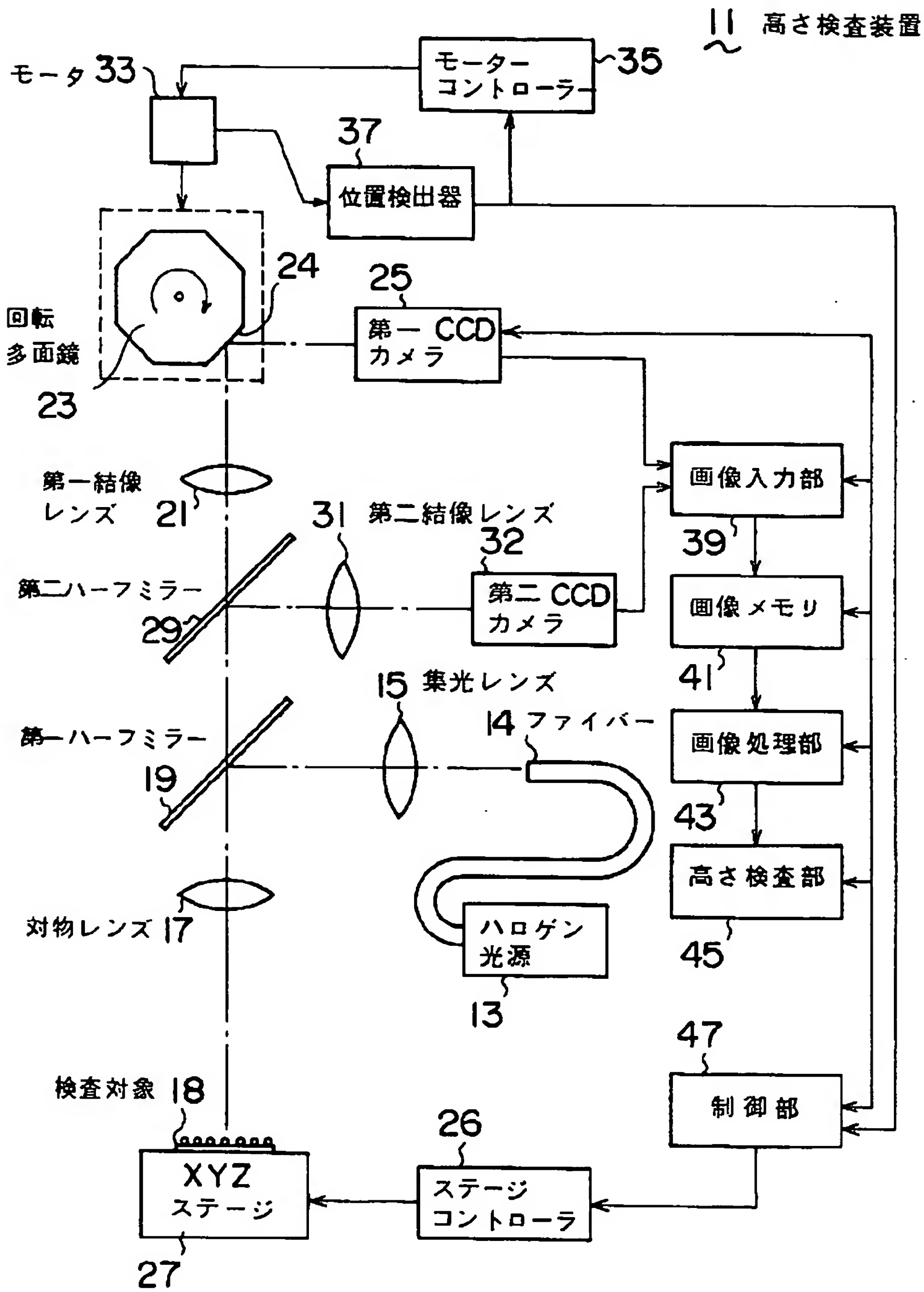
[Drawing 10]

ショート故障とオープン故障を説明する図



[Drawing 5]

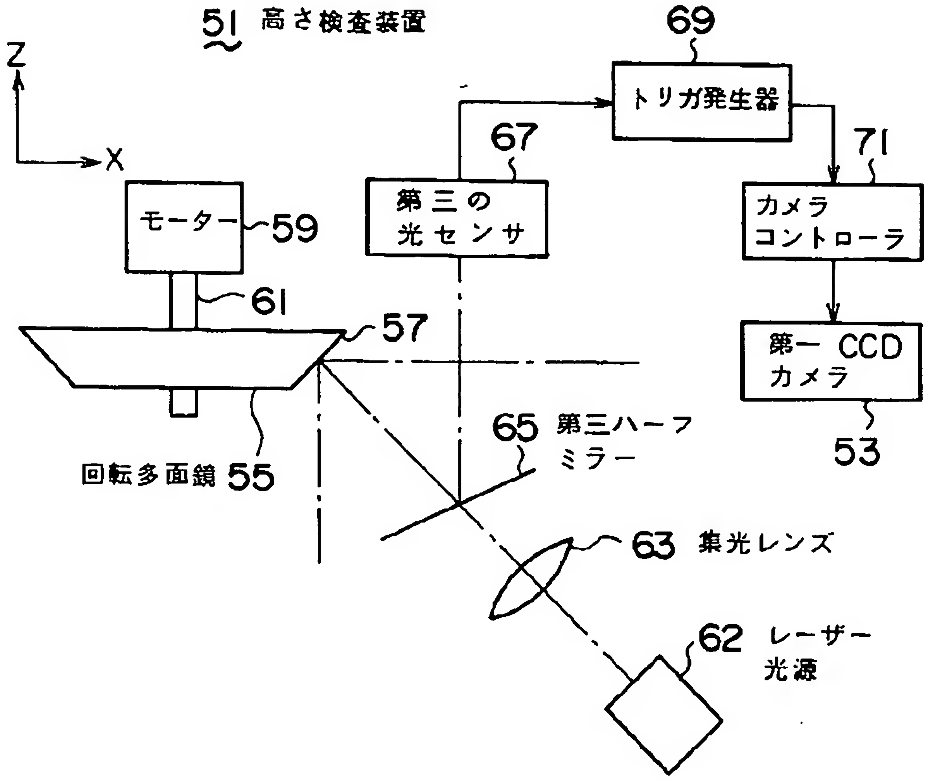
本発明にかかる第一実施例である高さ検査装置の
要部構成を示す構成図



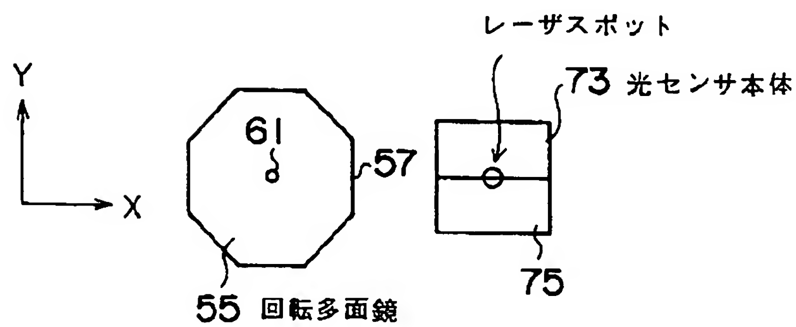
[Drawing 6]

本発明にかかる第二実施例である高さ検査装置の
要部構成を示す構成図

(a)



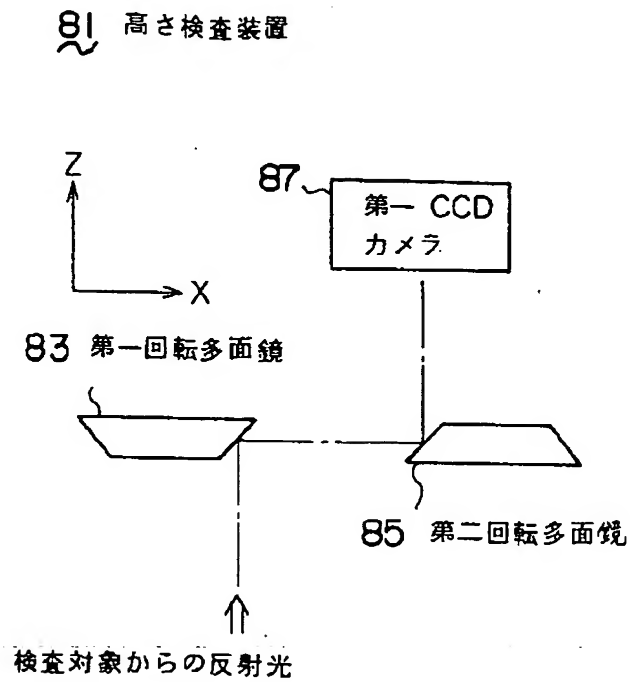
(b)



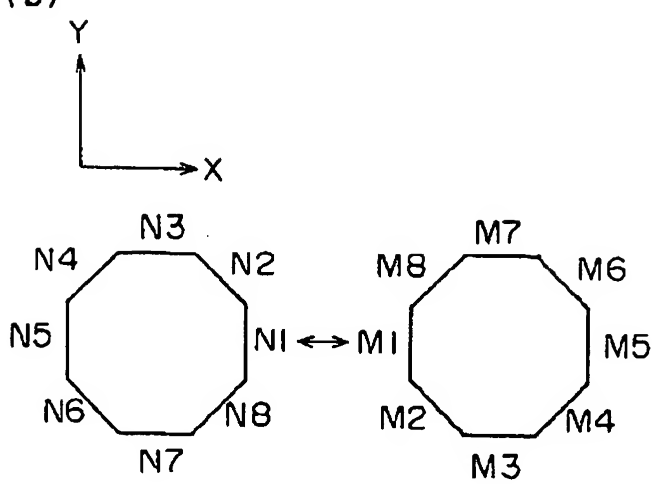
[Drawing 7]

本発明にかかる第三実施例である高さ検査装置の
要部構成を示す構成図

(a)



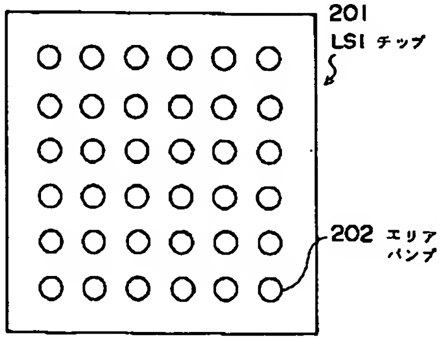
(b)



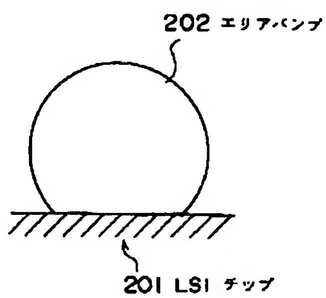
[Drawing 9]

ＬＳＩチップ上に形成されたエリアバンプの外観の概略図

(a)

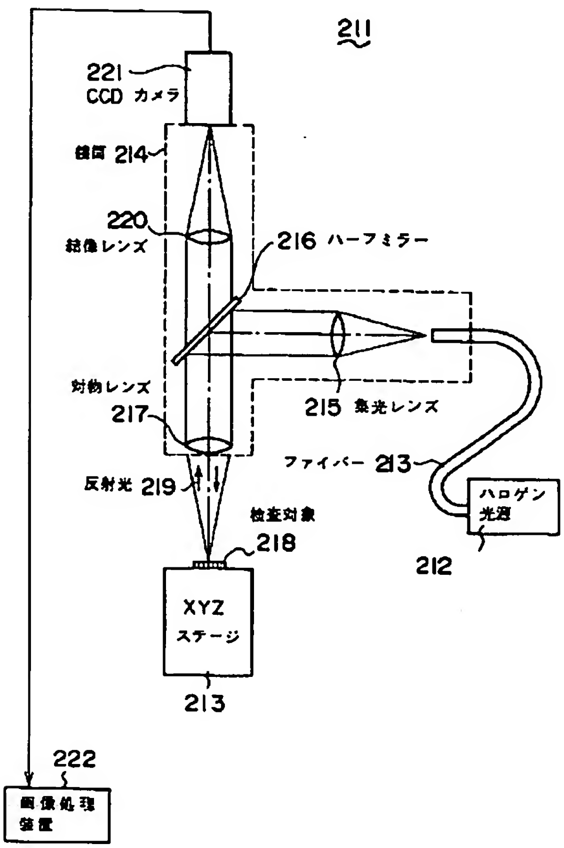


(b)



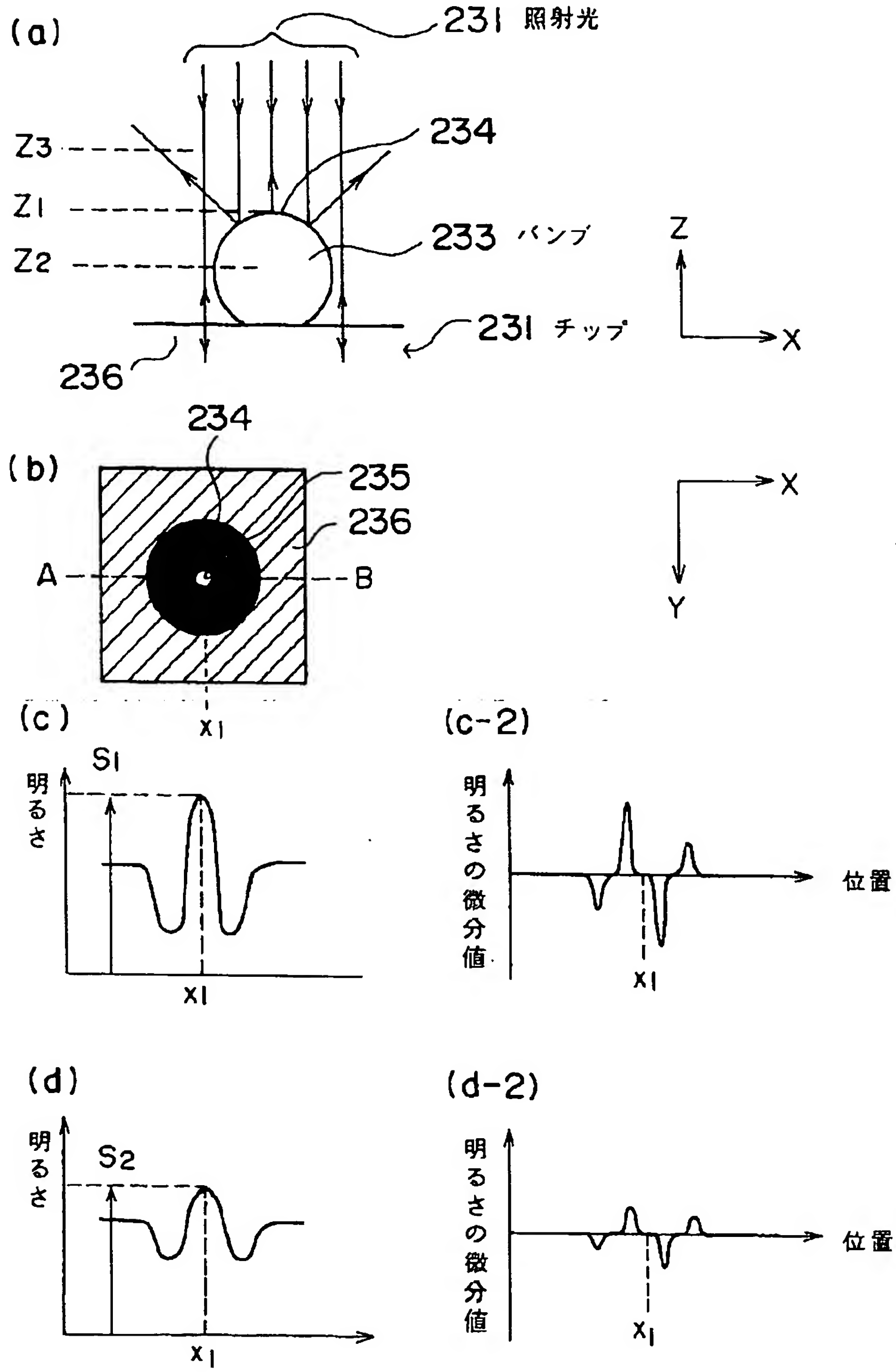
[Drawing 11]

従来の高さ検査装置の光学系の構成を示す図



[Drawing 12]

従来の高さ検査法を説明する図



[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] Height test equipment characterized by changing the optical path length between a subject of examination and the photosensor to provide in the height test equipment which inspects height to be examined, and having the optical system which changes this height information to be examined into the positional information on this photosensor.
[Claim 2] It is height test equipment characterized by being what said optical system possesses a movable reflective means in height test equipment according to claim 1, and changes height information to be examined into the positional information on said photosensor according to migration of this reflective means.
[Claim 3] in height test equipment according to claim 2, said optical system is equipped with the rotating polygon which consists of two or more reflectors where the distance from the center of rotation differs, said reflective means is constituted by the reflector of 1 chosen from these two or more reflectors, and migration of said reflective means is based on rotation of this rotating polygon -- this -- the height test equipment characterized by being made with selection of the reflector of 1.
[Claim 4] It is height test equipment characterized by being a multiple drill configuration with the substantial configuration which the reflector of said rotating polygon has an inclination toward the center of rotation in height test equipment according to claim 3, and this reflector constitutes, or a multiple frustum configuration.
[Claim 5] It is height test equipment with which the difference of distance is characterized by having a rough ****** part and a dense part from said center of rotation of said reflector where said rotating polygon adjoins further in height test equipment according to claim 3.
[Claim 6] It is height test equipment characterized by combining the mirror body with which said rotating polygon is constituted by said reflector where the distance from a medial axis used as said center of rotation is equal, and the field of the same number, and thickness differs on the field of this body on the rotating-polygon body whose configuration in a cross section perpendicular to this medial axis is a regular polygon substantially in height test equipment according to claim 3, and being formed.
[Claim 7] In height test equipment according to claim 2 said optical system It has two or more rotating polygons which consist of two or more reflectors where the distance from the center of rotation differs. Said reflective means It consists of each reflectors of two or more of two or more rotating polygons with the group of two or more reflectors chosen every one each. this -- migration of said reflective means this -- the height test equipment characterized by being what made by choosing a reflector from each reflectors of two or more of two or more rotating polygons by every one rotation each according to each center of rotation.
[Claim 8] In the height test equipment of claim 3 thru/or claim 6 given in any 1 term A light irradiation device, While providing further the second photosensor and the image processing system which performs the image processing for changing said height information to be examined into the positional information on this photosensor with directions of this second photosensor This light irradiation device and the second photosensor are set up so that the light from this light irradiation device may form the

optical axis and parallel condition of this photosensor at the time of the completion of selection of the reflector of 1 by rotation of the aforementioned rotating polygon. Height test equipment characterized by making this image processing by this image processing system by these directions that this photosensor detects formation of this parallel condition at the time of rotation of this rotating polygon, and follow this detection.

[Claim 9] In height test equipment according to claim 3, while said second photosensor consists of two or more bodies of a sensor These two or more bodies of a sensor are constituted so that other bodies of a sensor and the optical axis of each of the light from this light irradiation device at the time of the completion of selection of the aforementioned reflector may be pinched. Height test equipment characterized by being what detects formation of said parallel condition with the substantial identitas of the amount of detection of this light in each body of a sensor.

[Translation done.]